GRADE 12 DIPLOMA EXAMINATION

Chemistry 30

June 1984

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GRADE 12 DIPLOMA EXAMINATION
CHEMISTRY 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 55 multiple-choice questions each with a value of 1 mark.

PART B: Four written-response questions for a total of 15 marks.

A chemistry data booklet is provided for your reference. Approved calculators may be used.

GENERAL INSTRUCTIONS

Fill in the information on the answer sheet as directed by the examiner.

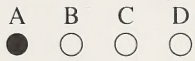
For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. Use an HB pencil only.

Example

This examination is for the subject area of

A. Chemistry
B. Biology
C. Physics
D. Mathematics

Answer Sheet



If you wish to change an answer, please erase your first mark completely.

For written-response questions, read each carefully and write your answer in the space provided in the examination booklet.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET.

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

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JUNE 1984

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PART A

INSTRUCTIONS

There are 55 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B.

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.

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1. In an endothermic reaction, the potential energy of the products, compared with that of the reactants, is

A. equal
B. lower
C. higher
D. either higher or lower

2. Given that the heat of formation for propane is -103.8 kJ/mol, it can be concluded that

A. energy is absorbed when propane is formed from its elements
B. 103.8 kJ of energy are released when one mole of propane burns
C. propane contains less energy than do the elements from which it is formed
D. propane contains more energy than do the elements from which it is formed

3. When solid aluminum at 660°C changes to molten aluminum at 660°C, its

A. kinetic energy decreases
B. potential energy increases
C. kinetic energy increases and potential energy remains constant
D. potential energy decreases and kinetic energy remains constant

4. Which of the following reactions releases the most energy?

A. $H_2O_{(g)} \longrightarrow H_2O_{(l)} + \text{energy}$

B. ${}^{2}_{1}H + {}^{3}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n + \text{energy}$

C. $H_{2(g)} + {}^{1}_{2}O_{2(g)} \longrightarrow H_2O_{(g)} + \text{energy}$

D. $NaCl_{(s)} + H_2O_{(l)} + \text{energy} \longrightarrow Na^{+}_{(aq)} + Cl^{-}_{(aq)} + H_2O_{(l)}$

5. A student heated ice at -20°C and took temperature readings every thirty seconds. Initially the temperature increased at each reading. Then there were three successive identical temperature readings. The inference is that the

A. melting point was reached
B. boiling point was reached
C. kinetic energy of the water molecules was dropping
D. potential energy of the water molecules was dropping

6. If the heat of formation for $H_2SO_{3(l)}$ is -768.0 kJ/mol, what is the value of ΔH for $SO_{2(g)} + H_2O_{(l)} \longrightarrow H_2SO_{3(l)}$?

A. $+1350.8$ kJ
B. $+185.2$ kJ
C. -185.2 kJ
D. -1350.8 kJ

Use the following information to answer questions 7 and 8.

In an experiment to determine the heat of dissolving $KOH_{(s)}$ in $H_2O_{(l)}$, the following data were obtained:

mass of $KOH_{(s)}$ = 2.30 g
mass of $H_2O_{(l)}$ in the calorimeter = 100.0 g
initial temperature of water = 20.3°C
final temperature of solution = 26.7°C
time for $KOH_{(s)}$ to dissolve = 43 s

7. The dependent (responding) variable in this experiment is most likely

A. time
B. mass of $H_2O_{(l)}$
C. mass of $KOH_{(s)}$
D. temperature change

8. Which interpretation of the data is justified?

A. The reaction is endothermic.
B. Heat is absorbed by the reaction.
C. The reaction is not stoichiometric.
D. The reactants have more potential energy than do the products.

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9. The heat of formation of butane is -125 kJ/mol. If 10.0 mol of butane are formed, then

A. 1.25×10^3 kJ of heat will be released
B. 1.25×10^3 kJ of heat must be added
C. 10.0 mol of oxygen must be available
D. 40.0 mol of oxygen must be available

10. During formation from elements, the heat emitted per mole would be greatest for

A. ethanol
B. sucrose
C. glucose
D. octane

11. If the equation $4NH_{3(g)} + 7O_{2(g)} \longrightarrow 4NO_{2(g)} + 6H_2O_{(g)} + 1132$ kJ were balanced using one mole of ammonia, the ΔH would be

A. -1132 kJ
B. -283 kJ
C. $+283$ kJ
D. $+1132$ kJ

Use the following information to answer question 12.

$$S_{(s)} + H_{2(g)} \longrightarrow H_2S_{(g)} + 20.1 \text{ kJ}$$
$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(l)} + 571.8 \text{ kJ}$$
$$S_{(s)} + O_{2(g)} \longrightarrow SO_{2(g)} + 296.9 \text{ kJ}$$

12. The heat of reaction for $2H_2S_{(g)} + 3O_{2(g)} \longrightarrow 2H_2O_{(l)} + 2SO_{2(g)}$ is

A. -1125.4 kJ
B. -888.8 kJ
C. $+1125.4$ kJ
D. $+1205.8$ kJ

---

13. The hydrocarbon that will yield the LEAST energy when one mole is burned in the presence of excess oxygen is

A. methane, $CH_{4(g)}$
B. ethane, $C_2H_{6(g)}$
C. propane, $C_3H_{8(g)}$
D. octane, $C_8H_{18(l)}$

Use the following information to answer question 14.

$$C_{(s)} + 2H_{2(g)} \longrightarrow CH_{4(g)} + \text{energy}$$

14. The energy released in this reaction is called the heat of

A. fusion
B. combustion
C. formation
D. decomposition

Use the following information to answer question 15.

In an experiment, 2.86 g of $NaOH_{(s)}$ were dissolved in 100.0 mL of water. The following temperatures were recorded:

Initial temperature of water 22.1°C
Final temperature of solution 31.2°C

15. The quantity of heat gained by the solution as the solution formed was

A. 0.40 kJ
B. 1.2 kJ
C. 2.4 kJ
D. 3.8 kJ

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16. 1.6 g of $NaOH_{(s)}$ were dissolved in 200 mL of $H_2O_{(l)}$. The temperature of the solution increased by 2.0°C. The heat released per mole of $NaOH_{(s)}$ dissolving was

A. 1.1 kJ
B. 1.7 kJ
C. 42 kJ
D. 170 kJ

17. A student was designing an experiment to determine the molar heat of combustion of sylvic acid, $C_{20}H_{30}O_2$. Which of the following would NOT be needed for the calculation of heat of combustion?

A. Mass of sylvic acid burned
B. Mass of water in the calorimeter
C. Temperature change of the sylvic acid
D. Temperature change of the water

18. In the reaction $CO_{(g)} + \frac{1}{2}O_{2(g)} \longrightarrow CO_{2(g)} + 283$ kJ, the heat of reaction for the production of 2 mol of $CO_{2(g)}$ is

A. -566 kJ
B. -283 kJ
C. $+283$ kJ
D. $+566$ kJ

19. In an operational definition of acids, one CANNOT say that they

A. are bitter to the taste and turn red litmus blue
B. react with baking soda to produce water
C. are sour to the taste and rough to the touch
D. react with magnesium metal to produce $H_{2(g)}$

20. Adding $OH^-_{(aq)}$ drop by drop to a solution of $H_3O^+_{(aq)}$ would

A. generate hydrogen gas
B. decrease the basic properties
C. decrease the amount of $H_2O_{(l)}$
D. decrease the acidic properties

21. According to the Brønsted-Lowry theory, the two acids in the reaction $HSO^-_{4(aq)} + HCO^-_{3(aq)} \rightleftharpoons H_2CO_{3(aq)} + SO^{2-}_{4(aq)}$ are

A. $HCO^-_{3(aq)}$ and $H_2CO_{3(aq)}$

B. $HSO^-_{4(aq)}$ and $HCO^-_{3(aq)}$

C. $HSO^-_{4(aq)}$ and $H_2CO_{3(aq)}$

D. $HSO^-_{4(aq)}$ and $SO^{2-}_{4(aq)}$

22. If acid $HX_{(aq)}$ is stronger than acid $HY_{(aq)}$, then

A. $HY_{(aq)}$ will have a lower pH than will $HX_{(aq)}$
B. $HX_{(aq)}$ will have a lower $[H_3O^+_{(aq)}]$ than will $HY_{(aq)}$
C. $HY_{(aq)}$ will conduct electricity better than will $HX_{(aq)}$
D. $HX_{(aq)}$ will have a greater percentage reaction with water than will $HY_{(aq)}$

Use the following information to answer question 23.

$$CO_3^{2-}{}_{(aq)} + H_2O_{(l)} \rightleftharpoons HCO_3^-{}_{(aq)} + OH^-_{(aq)}$$

23. $CO_3^{2-}{}_{(aq)}$ acts as a Brønsted-Lowry base because it

A. releases OH^-
B. reacts with $H_2O_{(l)}$
C. accepts a proton
D. donates a proton

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24. Strong acids are strong electrolytes because

A. they dissolve as molecules
B. they have a lower pH than do bases
C. they have a high percentage dissociation
D. any aqueous solution is a strong electrolyte

25. The pH of a detergent solution is 9.60. Its $[H_3O^+_{(aq)}]$ is

A. 4.4×10^{-1} mol/L
B. 1.0×10^{-9} mol/L
C. 2.5×10^{-10} mol/L
D. 9.6×10^{-14} mol/L

26. If a strip of litmus paper is dipped into a solution with pH = 9.0, the litmus color is

A. red
B. pink
C. colorless
D. blue

27. A reaction has an endpoint at $[H_3O^+_{(aq)}] = 1 \times 10^{-5}$ mol/L. The indicator that can be used in this titration is

A. methyl orange
B. phenolphthalein
C. bromothymol blue
D. methyl red

28. If a solution has a pH of 4.0, then the $[OH^-_{(aq)}]$ will be

A. 1×10^{-3} mol/L
B. 1×10^{-4} mol/L
C. 1×10^{-6} mol/L
D. 1×10^{-10} mol/L

29. The net ionic equation for the reaction between solutions of $NaHSO_4$ and $NaHCO_3$ is

A. $HSO^-_{4(aq)} + CO^{2-}_{3(aq)} \leftrightharpoons HCO^-_{3(aq)} + SO^{2-}_{4(aq)}$

B. $HSO^-_{4(aq)} + HCO^-_{3(aq)} \leftrightharpoons CO^{2-}_{3(aq)} + H_2SO_{4(aq)}$

C. $HSO^-_{4(aq)} + HCO^-_{3(aq)} \leftrightharpoons H_2CO_{3(aq)} + SO^{2-}_{4(aq)}$

D. $HSO^-_{4(aq)} + HCO^-_{3(aq)} \leftrightharpoons HSO^-_{4(aq)} + HCO^-_{3(aq)}$

30. MOST strong acid-base reactions may be represented by the equation

A. $H_3O^+_{(aq)} + OH^-_{(aq)} \leftrightharpoons 2HOH_{(l)}$

B. $HClO_{4(aq)} + H_2O_{(l)} \leftrightharpoons ClO^-_{4(aq)} + H_3O^+_{(aq)}$

C. $H_3O^+_{(aq)} + O^{2-}_{(aq)} \leftrightharpoons OH^-_{(aq)} + H_2O_{(l)}$

D. $H_2SO_{4(aq)} + H_2O_{(l)} \leftrightharpoons HSO^-_{4(aq)} + H_3O^+_{(aq)}$

31. A weak solution extracted from beetroot reacts with water according to the following equation: $HR_{(aq)} + H_2O_{(l)} \leftrightharpoons H_3O^+_{(aq)} + R^-_{(aq)}$. In acidic solutions this substance is red, and in basic solutions it is green. A correct inference is that the green substance is

A. $R^-_{(aq)}$

B. $HR_{(aq)}$

C. $H_3O^+_{(aq)}$ and $R^-_{(aq)}$

D. $HR_{(aq)}$, $H_3O^+_{(aq)}$, and $R^-_{(aq)}$

32. A student titrates 10.0 mL of H_2SO_4 solution with 0.020 mol/L NaOH solution. If 30.0 mL of $NaOH_{(aq)}$ are required to completely neutralize the solution, the concentration of the H_2SO_4 solution is

A. 6.0×10^{-2} mol/L
B. 3.0×10^{-2} mol/L
C. 6.7×10^{-3} mol/L
D. 3.3×10^{-3} mol/L

33. When 100 mL of 1 mol/L HCl solution are added to 100 mL of 2 mol/L NaOH solution, the final solution has

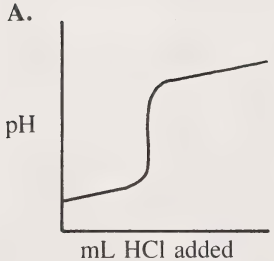
A. a pH greater than 7
B. a pH less than 6
C. $[OH^-_{(aq)}]$ equal to $[H_3O^+_{(aq)}]$
D. $[OH^-_{(aq)}]$ equal to $[H_2O_{(l)}]$

34. The substance that would be classified as an Arrhenius base is

A. $HOOCCOOH_{(l)}$
B. $Ba(OH)_{2(s)}$
C. $KMnO_{4(s)}$
D. $NH_{3(g)}$

35. A 0.1 mol/L KOH solution is titrated with 0.1 mol/L HCl solution. The relationship between pH and volume of HCl solution added is best represented by the graph

A.



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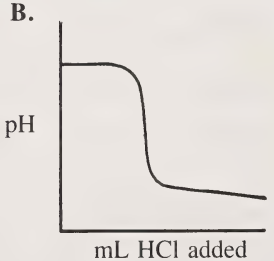

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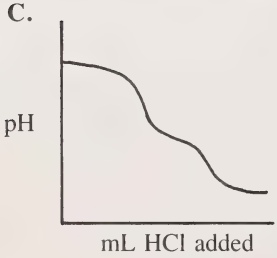
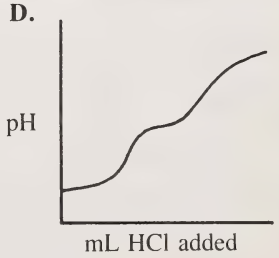


D.



36. The reaction in which the state of equilibrium favors reactants more than products is

A. $HF_{(aq)} + HSO_{4(aq)}^{-} \leftrightharpoons H_2SO_{4(aq)} + F_{(aq)}^{-}$

B. $H_3PO_{4(aq)} + HS_{(aq)}^{-} \leftrightharpoons H_2PO_{4(aq)}^{-} + H_2S_{(aq)}$

C. $H_2SO_{3(aq)} + SO_{3(aq)}^{2-} \leftrightharpoons HSO_{3(aq)}^{-} + HSO_{3(aq)}^{-}$

D. $CH_3COOH_{(aq)} + HCO_{3(aq)}^{-} \leftrightharpoons H_2CO_{3(aq)} + CH_3COO_{(aq)}^{-}$

37. $N_2O_{4(g)} + Cl_{2(g)} + 2H_2O_{(l)} \longrightarrow 2NO_{3(aq)}^{-} + 2Cl_{(aq)}^{-} + 4H_{(aq)}^{+}$
The oxidizing agent in this reaction is

A. $H_{(aq)}^{+}$
B. $H_2O_{(l)}$
C. $N_2O_{4(g)}$
D. $Cl_{2(g)}$

38. An example of an ion that may act as both an oxidizing and a reducing agent is

A. $Sn_{(aq)}^{2+}$
B. $Cl_{(aq)}^{-}$
C. $Ca_{(aq)}^{2+}$
D. $Mg_{(aq)}^{2+}$

39. $Zn_{(s)}$ reacts with $HCl_{(aq)}$. The net ionic equation for the reaction is

A. $Zn_{(s)} + Cl_{2(g)} \longrightarrow ZnCl_{2(aq)}$

B. $Zn_{(s)} + 2HCl_{(aq)} \longrightarrow ZnH_{2(aq)} + Cl_{2(g)}$

C. $Zn_{(s)} + 2H_{(aq)}^{+} \longrightarrow Zn_{(aq)}^{2+} + H_{2(g)}$

D. $Zn_{(aq)}^{2+} + Cl_{2(g)} \longrightarrow Zn_{(s)} + 2Cl_{(aq)}^{-}$

40. In the reaction $2NO_{3(aq)}^{-} + 4H_{(aq)}^{+} + 2I_{(aq)}^{-} \longrightarrow 2NO_{2(g)} + 2H_2O_{(l)} + I_{2(s)}$, the reducing agent is

A. $NO_{3(aq)}^{-}$
B. $I_{(aq)}^{-}$
C. $H_2O_{(l)}$
D. $I_{2(s)}$

41. In the electrolysis of $Cu^{2+}_{(aq)}$, a current of 1.75 A flows for 3.50 h. The mass of copper produced is

A. 14.5 g
B. 7.26 g
C. 0.121 g
D. 0.00202 g

42. Reduction potentials are relative numbers for which the zero point has been assigned to the reaction of

A. hydrogen ions forming hydrogen gas
B. fluorine gas forming fluoride ions
C. lithium ions forming lithium metal
D. water forming hydrogen ions and hydroxide ions

43. 0.710 g of $Cl_{2(g)}$ is collected by the electrolysis of $CaCl_{2(l)}$. The mass of $Ca_{(s)}$ collected is

A. 1.42 g
B. 0.802 g
C. 0.710 g
D. 0.401 g

44. The maximum voltage of a silver-chlorine electrochemical cell under standard conditions is

A. +2.16 V
B. +0.56 V
C. −0.56 V
D. −2.16 V

45. A spontaneous redox reaction is one in which

A. corrosion is rapid
B. a catalyst is needed
C. the E°_{net} is greater than 0.0 V
D. the anode is oxidized

46. Under standard conditions, which of the following reactions would be spontaneous?

A. $Sn^{4+}_{(aq)} + 2Br^{-}_{(aq)} \longrightarrow Sn^{2+}_{(aq)} + Br_{2(l)}$

B. $I_{2(s)} + 2Cl^{-}_{(aq)} \longrightarrow 2I^{-}_{(aq)} + Cl_{2(g)}$

C. $Pb_{(s)} + Zn^{2+}_{(aq)} \longrightarrow Pb^{2+}_{(aq)} + Zn_{(s)}$

D. $3Co_{(s)} + 2Fe^{3+}_{(aq)} \longrightarrow 3Co^{2+}_{(aq)} + 2Fe_{(s)}$

47. A 1.0 mol/L $Co(NO_3)_2$ solution can be stored in a container made of

A. tin
B. iron
C. chromium
D. zinc

48. The ion that will oxidize $Pb_{(s)}$ to $Pb^{2+}_{(aq)}$ but will NOT oxidize $Fe^{2+}_{(aq)}$ to $Fe^{3+}_{(aq)}$ is

A. $Ag^{+}_{(aq)}$
B. $Sn^{2+}_{(aq)}$
C. $Cr^{3+}_{(aq)}$
D. $Sn^{4+}_{(aq)}$

49. In electrolysis, a cell

A. resembles a discharging battery
B. has oxidation occurring at the cathode
C. spontaneously produces an electric current
D. converts electrical energy to chemical energy

50. In the electrolysis of aqueous tin(II) bromide, the species produced at the cathode would be

A. $Sn_{(s)}$
B. $Br_{2(l)}$
C. $H_{2(g)}$ and $OH^{-}_{(aq)}$
D. $O_{2(g)}$ and $H^{+}_{(aq)}$

51. Which of the following is the strongest reducing agent?

A. $K^+_{(aq)}$
B. $F_{2(g)}$
C. $Mg_{(s)}$
D. $Cl^-_{(aq)}$

52. In which of the following processes does the reactant lose electrons?

A. $Cr_2O_7^{2-}{}_{(aq)} \longrightarrow Cr^{3+}_{(aq)}$

B. $Fe^{2+}_{(aq)} \longrightarrow Fe^{3+}_{(aq)}$

C. $NO^-_{3(aq)} \longrightarrow N_2O_{4(g)}$

D. $SO_4^{2-}{}_{(aq)} \longrightarrow SO_3^{2-}{}_{(aq)}$

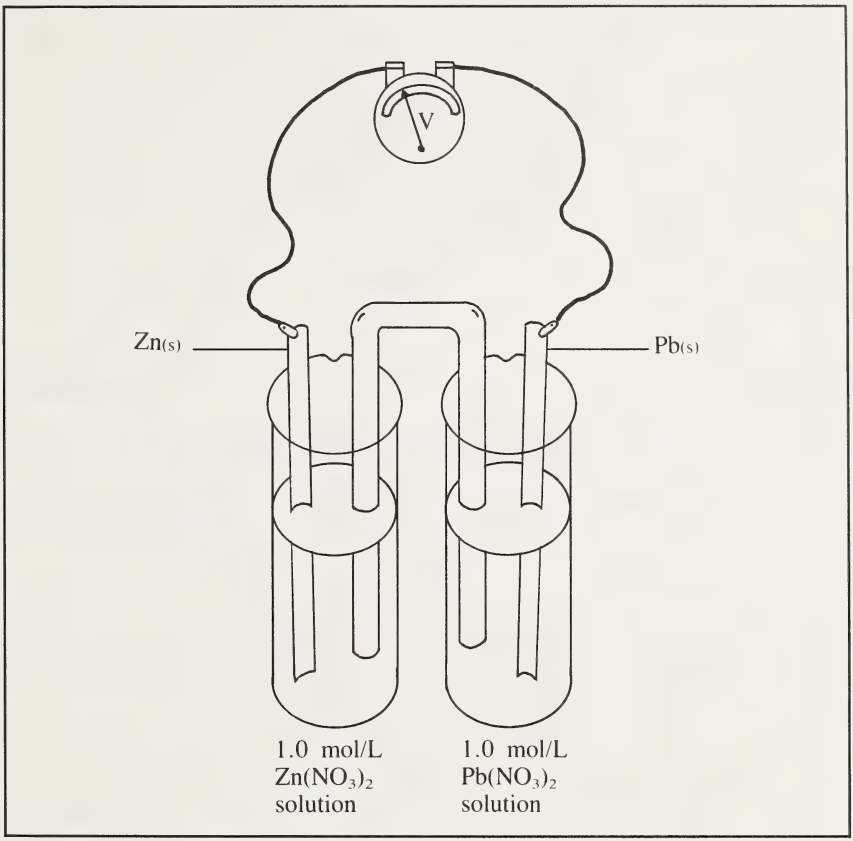
53. The E^0_{net} for the reaction between $Al_{(s)}$ and $Br_{2(l)}$ under standard conditions is

A. -2.73 V
B. -0.59 V
C. $+0.59$ V
D. $+2.73$ V

54. How many moles of $Al_{(s)}$ can be oxidized by 1 mol of $Cr_2O_7^{2-}{}_{(aq)}$ in an acidified solution?

A. 1
B. 2
C. 4
D. 6

Use the following information to answer question 55.



55. During the operation of the above cell,

A. $Pb_{(s)}$ is oxidized
B. $Zn_{(s)}$ is oxidized
C. $Zn^{2+}_{(aq)}$ is reduced
D. electron flow through the wire is from $Pb_{(s)}$ to $Zn_{(s)}$

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

Show all pertinent calculations and formulas, and give your answers to the correct number of significant figures.

TOTAL MARKS: 15

START PART B IMMEDIATELY

(USE FOR ROUGH WORK ONLY)

1. A student who was attempting to calculate the molar heat of fusion of ice dropped an ice cube into a calorimeter containing water. The data obtained are tabulated below.

Mass of ice at 0.0°C	52.8 g
Volume of water in calorimeter	100.0 mL
Temperature of water and calorimeter before ice was added	45.8°C
Temperature of water and calorimeter after ice had melted	2.3°C

(1 mark) **a.** Calculate the heat lost by the water originally in the calorimeter.

(1 mark) **b.** Calculate the heat gained by the cold water that formed when the ice melted.

(3 marks) **c.** Calculate the molar heat of fusion (melting) of ice.

(USE FOR ROUGH WORK ONLY)

2. 20.0 mL of a 0.020 mol/L HCl solution were titrated with a 0.010 mol/L KOH solution.

(1 mark) **a.** Determine the volume of base solution required to reach the endpoint.

(2 marks) **b.** Draw a titration curve for the reaction and label the axes.

(1 mark) **c.** Suggest an indicator that would be appropriate for this titration.

(USE FOR ROUGH WORK ONLY)

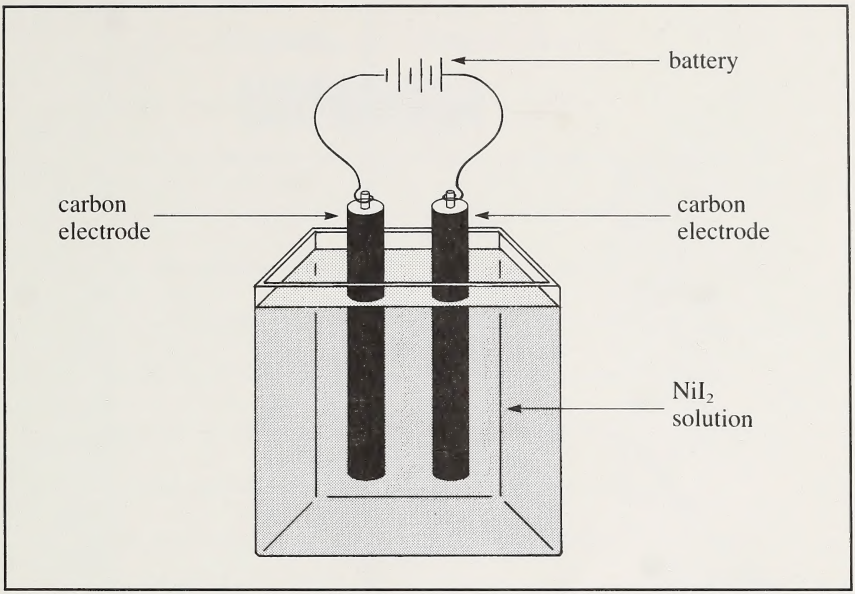
3. A sample of tin ore is dissolved in acid and all of the tin is converted to $Sn^{2+}_{(aq)}$. The entire solution is titrated with 0.12 mol/L $Ce^{4+}_{(aq)}$, which oxidizes the tin to $Sn^{4+}_{(aq)}$. $Ce^{4+}_{(aq)}$ is converted to $Ce^{3+}_{(aq)}$ in the reaction. The endpoint is reached when 74.8 mL of $Ce^{4+}_{(aq)}$ have been added.

(1 mark) **a.** Write a balanced net ionic equation for the reaction.

(2 marks) **b.** Calculate the number of moles of tin in the ore sample.

(USE FOR ROUGH WORK ONLY)

4.

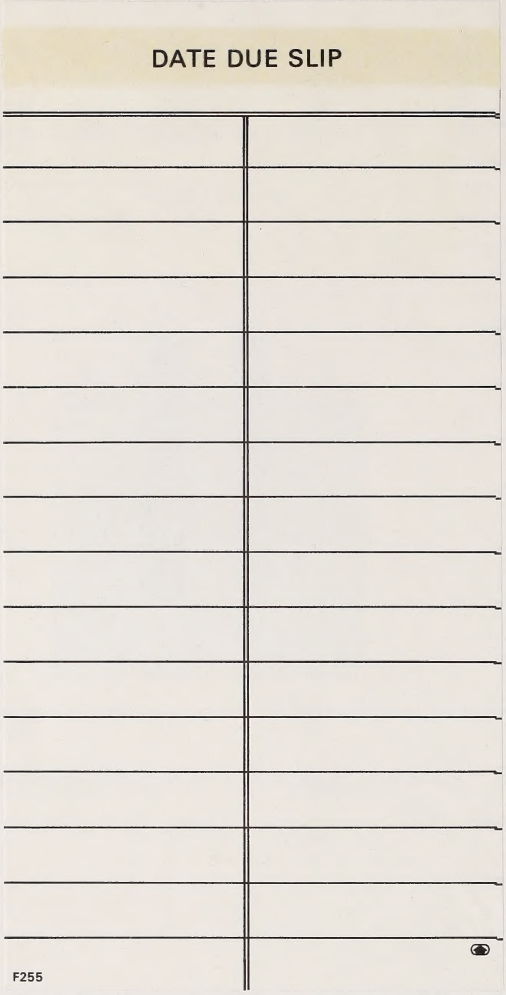


(1 mark) **a.** Write the equation for the half-reaction that would occur at the anode.

(1 mark) **b.** What product would be formed at the cathode?

(1 mark) **c.** What is the theoretical minimum voltage that must be exceeded to make this electrolysis occur at standard conditions?

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.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